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LAND USE DATA: NEEDS AND SOURCES

ROBERT C. OTTE AND WILLIAM M. CROSSWHITE

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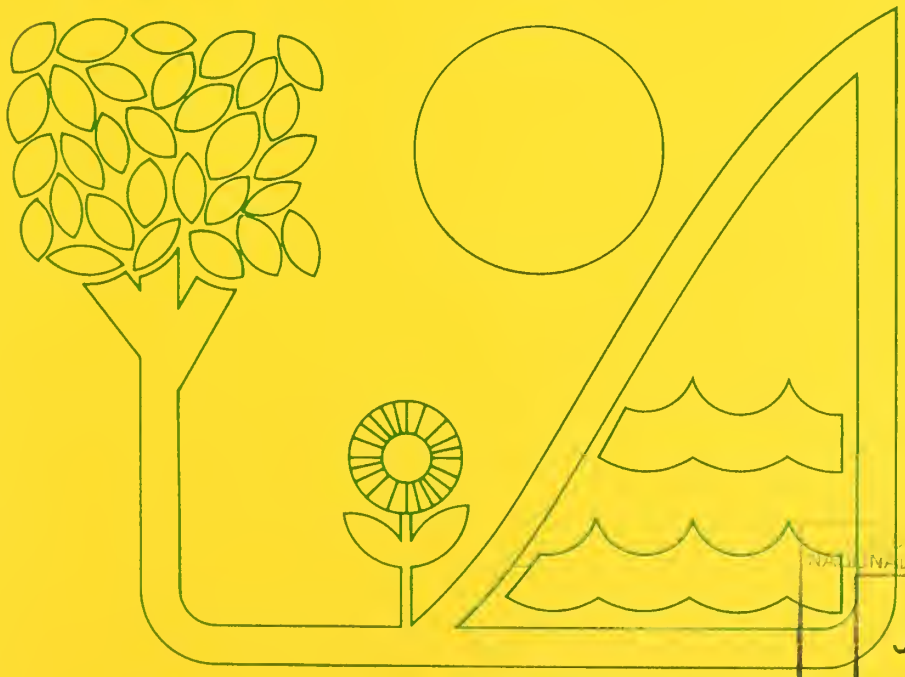

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Robert C. Otte and William M. Crosswhite**

Abstract

Decisions are based on information. Information is the result of an analytical process or system that uses data as an input. Land use information systems require data of three basic types: land use, land capability, and landownership. Each of these types requires a classification system based on relevant characteristics to provide specifications for data and organize it for use in information systems. Geographic breakdown is also an important dimension of land use data. The traditional sources of land use data have been the Censuses of Agriculture and Population, the Forest Survey, the National Inventory of Soil and Water Conservation Needs (CNI), crop acreage reports of the Statistical Reporting Service, the major land use series of the Economic Research Service, and reports and records of the Bureau of Land Management, Park Service, Forest Service, and other governmental agencies that hold and manage land. The Land Inventory and Monitoring Program (LIM) of the Soil Conservation Service, the Land Use Data and Analysis Program (LUDA) of the U.S. Geological Survey, and other new and emerging sources of data are discussed.

Perspective

Concern for land use stems from problems of escalating food prices, rising land prices, a declining supply of prime agricultural land, environmental degradation associated with land tillage, mining, construction, and other developmental activities, and the need to control development patterns. Traditionally, land and associated water and mineral resources have been viewed either as elements of the natural environment or as inputs to economic production. Dynamic changes in technology and public investments, plus a growing world market, have created the need for multi-purpose use of resources.

Technical, economic, and institutional changes have increased the complexity of land use planning and the need for land use information systems. They have also increased the costs of providing pertinent and accurate economic information for land use planning.

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Land use planning information should focus on the use, conservation, development, and control of land and related resources, as well as on environmental quality aspects of land use. What are the issues? Basic information on ownership of land and other resources of rural America has become increasingly inadequate and outdated. Within agriculture, major structural changes have concentrated control in the hands of fewer that 1.7 million commercial farmers and have rendered obsolete many traditional land tenure concepts and values. We especially lack information on the extent to which large-scale corporations and agribusiness firms have acquired control of rural land.

Information on the cropland base is needed to appraise production potential. This information becomes the basic input into interagency activities such as river basin planning and national-regional production models. Consistent and uniform data are needed on the cropland base, land productivity, and movement of land into and out of cropland use.

Shifts in resource use and changes in the land resource base are increasingly important considerations in meeting world food demands. We need to assess the impact of rising land prices, technology changes, environmental regulations, shifting tax policies, rising consumer incomes, and related economic and social factors. There is a need to understand land supply elasticities, i.e., how much land comes into or goes out of production as commodity prices vary.

Data and Information

There is increasing concern about this need for adequate data and information. The incoming president of the AAEA, James Bonnen, devoted the 1975 presidential address to the subject. 1/ (His selection of this theme stemmed from his work with the Economic Statistics Committee of the AAEA.) Bonnen states that although agricultural economics has a better track record than many other fields of economics for maintaining an empirical orientation and for generating high-quality, relevant data and information, of late the field has been slipping in this regard. His appraisal would probably also hold for the more specialized area of resource economics.

Bonnen emphasizes the difference between information and data. Data are the raw material of information. "Information is a process which imposes form and gives meaning." The real world is infinitely

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1/ James T. Bonnen. Improving Information on Agriculture and Rural Life. Presidential address to the American Agricultural Economics Association, Columbus, Ohio, August 11, 1975.

complex. An information system is a set of concepts which can portray and reduce this complexity by identifying the relevant elements. These concepts define data. "No matter how ad hoc the collection of data may seem, every measurement act is guided explicitly or implicitly by conceptual and value structures which exist prior to the act of measurement."

Although Bonnen sees a depletion in our capital stock of data, he does not fault the statistitians and data gatherers as much as the economists. Economists are responsible for developing the concepts that define and specify data. The deterioration of data has been not a loss in quantity but a loss in relevancy. And this results from failure to maintain and develop the conceptual framework (information system) that specifies what constitutes data.

Ideally then, in drawing up the specifications for land use data, it would be necessary to analyze the decision-making process in land use planning, determine the kind and format of information needed for decisions, and design models or systems that would provide the needed information. The model or system would then prescribe the basic data needed and would provide specifications for a land use inventory or inventories. This procedure could be characterized as beginning at the top. In practice, we have usually begun at the bottom by intuitively designing a comprehensive or multiple-purpose land inventory that will meet most of the needs of most information systems, relying to some degree on feedback from data users, who could be characterized as engaged with information systems. Immediate concerns have been land use and capability classification systems, geographic breakdowns, and computer hardware and software.

While attack from the top is inherently more orderly and precise and intellectually more appealing than attack from the bottom, there has been little analysis of land use decisions to prescribe information needs from systems or models. But there are a number of systems and models in various stages of development and operation for selected types of land use decisions. The Natural Resource Economics Division of the Economic Research Service (ERS) employs linear programming and input-output models in its water resource planning activities. The models analyze land use patterns expected under different assumptions as to alternative resource development programs and production levels. Heady and associates at Iowa State University have been analyzing crop production patterns on a national scale. Some intricate and ambitious models have been designed but not implemented. Considerable testing is needed to develop a model that will provide the necessary output and will function with available data. Many models have been proven worthless because they require data that are unavailable--and possibly unobtainable.

Attack from the bottom can result in a preoccupation with computer hardware and the inclusion of all data available or easily obtainable, irrespective of its relevance. Data that are more difficult to obtain or for which the need is not immediately obvious may not get included. On the other hand, the inventory may be cluttered with data for which there is little use.

Specifying Data Needs

In considering data needs and sources, we really should analyze the decision-making process in land use planning and review existing models and systems, in both the design and operational stages, listing and categorizing the data required for them. That would give us a definite set of specifications for land use data.

But we have had to content ourselves with something less--a partly deductive, partly intuitive prescription of the type and form of land use data needed, augmented by feedback from ongoing land use planning processes and land use information systems.

Some surveys have been made of land use planners and other data users. The Soil Conservation Service and the U.S. Geological Survey questioned State and local government offices as to their land resource data needs. Their response indicated they wanted data of every imaginable type--data on the resource itself, its use, how its use is controlled. A subgroup of the USDA Committee on Planning and Policy for Land Use reviewed research and data needs. They concluded that the initial need is a classification scheme for data relevant to land use planning. Users could then be surveyed to determine the most essential data categories and establish priorities for obtaining these needed data. The subgroup set forth some specific data needs:

1. Physical and biological data--soil, geologic features, water, and vegetative cover, as well as land use productivity levels.

2. Social, economic, and institutional data--the number, location, and characteristics of the population; ownership, tenure, and use of resources; land improvement measures; farm management practices; fertilizer response of crops; production statistics; and resource laws and regulations that influence land use planning. 2/

2/ U.S. Department of Agriculture. Research and Data Needs for Land Use Planning: Report by the Basic Data and Research Subgroup to the Committee on Planning and Policy for Land Use and Land Conservation. 1974.

Another recent activity of the USDA Land Use Committee was the Seminar on the Retention of Prime Lands, held July 16-17, 1975. This resulted in the following recommendations regarding data:

1. Update and improve the resource data base, complete the national soil survey, and implement the USDA Land Inventory and Monitoring Program.

2. Computerize data in retrievable form, with easy access for users.

3. Seek socioeconomic data, including landownership data.

4. Define, classify, and locate prime and unique lands.

5. USDA should provide interdepartmental leadership in coordinating resource data collection and discrimination.

Relevant Attributes and Classification Systems

Relevant attributes of land have been treated generally within the framework of classification systems--an exercise predating the emergence of land economics and resource economics as identifiable subdisciplines. One landmark work is a 1941 report of the Natural Resources Planning Board. The report reviewed systems extant at that time and grouped them into five categories, depending on whether they classified land in terms of (1) inherent characteristics, (2) present use, (3) use capabilities, (4) recommended use, or (5) program effectuation. 3/ Another landmark report was that of a special committee organized by Resources for the Future which in 1964-65 surveyed ongoing programs for compiling land use statistics and made recommendations for improvement. 4/

A more recent work is that by Anderson and associates in the U.S. Geological Survey. They developed a two-level land use classification system that can be effected by high-altitude remote sensing. The system is designed so that classification based on attributes identifiable by low-altitude remote sensing and other means can be incorporated at additional levels of the system. This system has been widely reviewed by Federal and State agencies. Hopefully, it will be a step toward greater

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3/ Natural Resources Planning Board. Land Classification in the United States. Gov. Print. Off. 1941. P. 3.

4/ Marion Clawson and Charles L. Stewart. Land Use Information: A Critical Survey of U.S. Statistics Including Possibilities of Greater Uniformity. Johns Hopkins Press. 1965.

compatability and standardization among systems. 5/

Land use classification. We need to remind ourselves periodically that it is not possible to develop an all-purpose land use classification system. Each information need has a somewhat different set of specifications for data. However, there are similarities and complementarities, and a multiple-purpose system can serve many needs. Probably the greatest deficiency in present systems is the limited capacity to accommodate multiple uses of resources. Statistics are generally in terms of the "major" use, which really means the use singled out as most important for the purpose at hand. Subcategories provide some flexibility, but systems and tabular presentation rapidly become unwieldy if we try to account for multiple-use to any significant degree. However, the big increase in computer capacity in recent years probably has not been fully exploited in tackling this problem.

Capability classification. At the heart of land use planning is the matching of use with capability. Probably the most widely used capability system is that of the Soil Conservation Service, which is based on the nature and degree of physical limitations for cultivation and other agricultural uses. The class number (I through VIII) specifies the degree of limitation. Class I has virtually no limitations for cropping; classes V through VIII are generally unsuited for cultivation. Classes II through VIII are broken down by subclass, specifying the nature of the limitation--erosion, excess water, unfavorable soil conditions, and climate. 6/

For many aspects of land use planning, data on relative agricultural productivity of specific lands is necessary. The land capability classification system is often used as a surrogate for a productivity classification, although this has not been uniformly successful. In some ERS river basin studies, data have been developed from soil surveys or other sources to develop estimates of productivity from different types of land.

There is an increasing need to develop practical ways of grading land resources for agricultural potential. First, the national-regional models developed by ERS, Iowa State, and others to date have worked within the existing cropland base. Most projections of productivity have indicated a rate of increase more than adequate to provide for

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5/ James R. Anderson, Ernest E. Hardy, and John T. Roach. A Land-Use Classification System for Use With Remote-Sensor Data. Geol. Surv. Circ. 671. 1972.

6/ A. A. Klingebiel and P. H. Montgomery. Land Capability Classification System. U.S. Dept. Agr., Hdbk. No. 210. 1961.

projected population increases and modest increases in exports; hence no additional cropland would be needed. However, with prospects for increased exports, data are needed on potential cropland that could be brought into production to meet increased demands. Such projections require more refined data on the capacity of existing cropland to absorb more inputs (and thus increase output by intensified land use), as well as production possible from land brought in by expansion at the extensive margin.

Land Ownership. Ownership is an important and often overriding consideration in land use planning. While not traditionally considered in direct context with land use and capability systems, there is a parallel in that type of ownership and orientation of owners can be as important as present use and physical capability; and classification systems based on type of ownership are needed. Considerable effort has been devoted to development of information systems that would incorporate identification of parcels and data needed in titling systems with data on use and capability. 7/

Geographic Specificity

The geographic units for which land use data are compiled and tabulated have been compromises between the needs and the practicalities of acquisition and handling. For most data series, the county is the basic geographic unit, which creates at least two problems. First, many planning areas comprise portions of counties, and generalization along county boundaries is a poor and sometimes completely unsatisfactory substitute for the actual area.

The second problem concerns analysis of data and relationships between two or more relevant variables. In most cases, what is desired and needed is the association of attributes at the individual or site-specific level. In analyzing land use shifts using county data, for example, it is possible to observe only net increases in one use and net decreases in another for the county as a whole. One is forced to use association at the aggregate level as a surrogate for associations at the individual level. For many purposes, we need specific information on what land is shifting to what new use.

The use of grids and areal sampling can overcome some of these problems. A working paper of the Southern Land Economics Research Committee several years ago examined in detail the relative merits of alternative

7/ Robert N. Cook and James L. Kennedy, Jr., Editors. Proceedings of the Tri-State Conference on a Comprehensive Unified Land Data System (CULDATA). College of Law, Univ. of Cincinnati. 1967.

grid systems in land use information systems. 8/ The Subgroup of the USDA Committee on Planning and Policy for Land Use and Land Conservation pointed out the need for land resource data to be site-specific.

Another possibility for geographic breakdown is to use the ownership parcel as the basic unit; or at least to have parcel identification incorporated in a grid system that permits automation of ownership records and also provides the framework for land use and capability data. 9/

Current Sources of Land Use Data

Some States and many substate areas are well endowed with land use data. However, relatively few series or systems give consistent national coverage. These include the Censuses of Agriculture (including Irrigation and Drainage) and Population, the Forest Survey, the National Inventory of Soil and Water Conservation Needs (CNI), crop acreage reports of the Statistical Reporting Service, and the ERS major land use series. Although not available for the total U.S. land area, soil surveys contain much information relevant to land use. In addition, a large part of the country has been photographed from the air. Although airphotos are not data *per se*, they can provide a wealth of land use data, particularly historic data not available from any other sources. The satellite LANDSAT--and its predecessor, ERTS-A--have been scanning the earth's surface every 18 days since mid-1972. Their output of imagery and tapes is emerging as a prime source of current land use data.

The Census of Agriculture, repeated every 5 years, provides an accounting for use of land in farms--about 1.1 billion of the 2.3 billion-acre land area of the country (1.1 billion acres vs. the 1.8 billion total acreage of the 48 contiguous States). The Census gives an accounting for all cropland, with details for specific crops plus acreage in cultivated summer fallow, crop failure, cropland idle and in conservation use only, and cropland pasture. Acreage in pasture and range, woodland, farmsteads, and miscellaneous uses completes the accounting for land in farms. Data are compiled on a county basis.

The most important limitations of the Census of Agriculture are that data are not available for geographic areas smaller than a county, 5 years elapse between readings, and only about half of the U.S. land area is covered. (The proportion is higher in the better agricultural

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8/ Recommendations for a Natural Land Information System--A Working Paper Prepared by the Southern Land Economics Research Committee.

9/ D. David Moyer and Kenneth Paul Fisher, Land Parcel Identifiers for Information Systems, American Bar Foundation. Chicago. 1973.

areas.) Also, the Census definition of a farm has been narrowed to exclude units with little commercial agricultural activity, so the land area accounted for has shrunk even further. However, the Census of Agriculture remains our basic source of agricultural land use data on a national basis.

The Censuses of Drainage and Irrigation are carried out in conjunction with the Census of Agriculture and the Census of Governments. These provide data on acreages irrigated, sources of water, methods of water distribution, and other data related to land use. Data on areas drained are particularly difficult to obtain because it is not always clear just what land has benefitted from a drainage system. The fact that use of some cropland was originally brought in by drainage improvement may have been forgotten by those now tilling the land. The man-made or man-modified system of ditches may now be taken for granted as part of the natural drainage system.

The Census of Population provides a measure of sorts for land in urban use--or rather for land within places of 2,500 population or greater. For a number of years, ERS has used the area estimated by Census as being in "urbanized areas" plus any additional land in places of over 2,500 population as an estimate of land in urban use. Area estimates normally are not made for places under 2,500. However, the boundaries for urbanized areas and the places of over 2,500 are drawn on the generous side and include some agricultural and other rural land. This offsets, at least in part, the urban land in smaller places and the factories, commercial establishments, and residences scattered over the countryside. The Bureau of Economic Analysis, Department of Commerce, now uses basically this same approach and has county estimates available in automated format for 1970.

The main drawbacks of the Census of Population as the source of data on acreage in urban use are lack of precision and the 10-year lapse between Censuses.

The Forest Survey of the U.S. Forest Service has been inventorying the forest resources of the country on a rotating basis for the past 45 years. State surveys of timber resources are completed each year for 10 percent of the States. Thus, in any one 10-year period, the entire United States has been covered. Periodically, a national report is prepared, giving estimates of the timber resource for all States for one common year. The current report uses 1970 as the base year.

The Forest Survey provides the only source of nationwide data on acreages in woodland. It has two primary deficiencies as a source of land use data. First, for any given county, the data may be up to 10 years old. Thus, there may be a problem of consistency in aggregating

data for a number of counties. Second, land is classified on the basis of its potential for timber production. Some land is included that has other uses which for some data needs, may be more relevant. Also, shifts in definition of timber land over time can create problems in analyzing change. At times there are problems of accommodating forest survey data with Census data in accounting for the use of the total land area of a county.

The National Inventory of Soil and Water Conservation Needs (CNI) has been conducted twice by the Soil Conservation Service--with readings as of 1958 and 1967. It accounts for the 1.4 billion acres of non-urban, non-federal U.S. land; of which all but 6 million acres are in the 48 contiguous States. The CNI gives the only comprehensive data that cross-tabulate use by capability of the land resource. Statistics were developed on a county basis, classifying the non-urban, non-federal area by the 29 subclasses of the Soil Conservation Service's land capability system. 10/ The inventory acreage is broken down by 8 subcategories of cropland plus pasture, range, commercial and non-commercial forest land, and other land, cross-tabulated by land capability subclass.

Like the Census of Agriculture, CNI data are available on a county basis. 11/ Also, the time period between the two existing CNI's was 9 years; the interval until the next will probably be greater as there are no plans now underway for a new CNI.

The Statistical Reporting Service compiles annual acreage and production data on the 20 most important crops, which comprise 97 percent of the acreage of all crops. Data for most of these crops are available on a county basis from many State offices as part of cooperative SRS-State efforts, but this situation is not universal. Also, in its annual June Enumerative Survey, SRS has been obtaining for ERS data on cropland in fallow, idle, in soil conserving uses only, and cropland pasture. SRS has, thereby, been providing annual data, usable at the multistate level, on cropland in uses other than for harvested crops. Cropland pasture, however, has been very difficult to define, and ERS has been cautious in using both Census and SRS-derived estimates of it, particularly as between years.

The ERS Major Land Use Series, compiled every 5 years, was started in 1915. It has been in essentially its present format since 1945. 12/

10/ Klingebiel and Montgomery, Op. Cit.

11/ The primary data from which county estimates were made were obtained from a sample of plots, generally of 160 acres each, comprising about 2 percent of the inventory acreage. For some purposes, these sample plots can be recombined for ad hoc areas independent of county boundaries.

12/ H. Thomas Frey, Major Uses of Land in the United States. U.S. Dept. Agr., Econ. Rpt. No. 247. 1973.

It is the only ongoing effort to account for use of the entire land surface area of the country. Use classes covered are cropland (6 subclasses), forest and woodland (2 subclasses), grassland pasture and range, special uses (14 subclasses), and miscellaneous. Data on land in farms comes from the Census of Agriculture and SRS. Estimates of the use of land not in farms are based on data from the Forest Service, Bureau of Land Management, Census of Population, and numerous other Federal and State sources. For example, data on highway acreages are based on data from the Federal Highway Administration on mileages of different classes of roads. Data on acreages in parks, wildlife refuges, and defense establishments are obtained from the Federal and State agencies holding or administering such lands.

This ERS series reflects the shortcomings of the data on which it is based. The data are developed on a State and national basis only, and at 5-year intervals. It would be desirable to have more detailed categories of land use, a finer geographic breakdown, and greater provision for considering multiple uses of land.

Detailed soil surveys (Soil Conservation Service) exist for about 40 percent of the land area of the 48 contiguous States. About 80,000 different kinds of soils are now recognized in the United States, based on major properties such as soil depth, soil texture, slope, and hazards such as flooding and erosion. Published surveys at the county level contain soil maps, soil descriptions, and soil classifications. Estimated yields are given for relevant crops for defined levels of management. Since 1957, interpretation for engineering uses of soils, community planning, drainage needed, irrigation potential, and recreation and wildlife potentials are shown for each soil.

Soil surveys contain a wealth of data relevant to land use. The principal limitations are that soil surveys are not yet available for all areas and that the data are not in tabular form. However, data are site-specific and can be developed for virtually any geographic configuration.

Remote sensing, carried out earlier from interpretation of airphotos and more recently by automated techniques, has been an important source of land use data on an ad hoc basis. It is a prime source for the land use inventory now in progress in the U.S. Geological Survey, about which more will be said later.

Three streams of technology have been developing to make remote sensing emerge as an important source of land use data. First, the space program has produced the vehicles to carry sensors and enable frequent observation of crop production and land use phenomena. The LANDSAT vehicles (the first was launched in 1972) cover any given spot on the earth's surface every 18 days.

The second development is in sensors. Improved resolution, specialized narrow-band imagery, and expanded use of the infra-red range of the electro-magnetic spectrum has made possible many new applications for data application. For most types of data, this development gives real savings over acquisition of data by ground survey or other conventional methods. But, so long as human interpretation is required, time and labor costs will place definite limitations on these uses of remote sensing.

The third area of technology to be used in remote sensing is the computer. Sensors, particularly those operating continuously from orbiting space craft, produce overwhelming quantities of raw data. Using these data to develop signatures for specific land uses requires substantial computer capacity. In addition, information on each small area of the earth's surface must be geocoded so that it can be either displayed on a map or tabulated by county, river basin, or other category. This means computer storage and handling of very large quantities of data.

Massive comprehensive programs for obtaining data by remote sensing are probably some years away. Also, there are definite limits to what can be observed directly from above. However, such data can be made site-specific and tabulated and displayed in a variety of formats.

Data Developed by ERS in Resource Planning Assistance

ERS has for many years been a partner with other Federal and State agencies in water resource development planning. In more recent years, the agency has participated in developing the national assessment of the Nation's water resources for the Water Resources Council. It has also cooperated with the Bureau of Economic Analysis, U.S. Department of Commerce, in the OBERS projections of regional economic activity in the United States, carried out also for the Water Resources Council. These programs, as well as a great many studies of individual river basins and water resource areas, have resulted in the acquisition of much land use and land capability data. Most of the data are automated. The basic sources were those discussed previously--the Census, CNI, soil surveys, and SRS data. However, some supplemental primary data have been obtained, adaptions made, and additional estimates made for planning work. Also, future land requirements and land use patterns have been projected under varying assumptions as to population, level of technology, and level of product exports. While not data per se, these projections do have a vast amount of quantification usable for projections for other purposes.

As part of these activities, ERS had developed the following automated basic data files and retrieval systems:

1. Census data bank--county and State data on acres, production, and production inputs from the Agricultural Censuses of 1949, 1954, 1959, 1964, and 1969. County data are codified for aggregation by land resource areas and water resource regions.

2. CNI--contains the published 1967 data on a county basis, codified for the same multicounty areas and regions as the Census data bank.

3. SRS annual data--State data on acres, production, yield, price, and values for all major commodities compiled by SRS. Time series start in 1939 and run through 1971.

As was pointed out above, ERS has been producing a basic land use inventory for some time. It has been processing data from other sources such as the Census, CNI, and SRS. It has been generating some new data in river basin studies and in its work with national-regional models. However, not all these data are comparable. Different base years have been used. Different soil groupings have been employed in developing productivity estimates. Some geographic breakdowns have not been compatible. There is currently underway in Natural Resource Economics Division of ERS the development of a Resource Base and Producitivity System comprising a consistent set of regional-national base information that will serve the research and analytical needs of resource inventories, resource analysis and projections, and environmental and planning assistance studies.

Emerging Data Sources and Information Systems

LIM Program. The Rural Development Act of 1972 directed the Department of Agriculture "to carry out a land inventory and monitoring program to include, but not be limited to, studies and surveys of erosion and sediment damages, flood plains identification and utilization, land use changes and trends, and degradation of the environment resulting from improper use of soil, water, and related resources." One of the purposes of this inventory and monitoring program identified by the Act is identification of prime agricultural producing areas.

Although the activities called for by the Act have had only limited funding, the Soil Conservation Service has established a LIM (land inventory and monitoring) program with several data gathering projects now underway. One is the mapping of important agricultural land--land meeting SCS-developed criteria for being denoted "prime" or "unique", plus land designated at the State and local levels or being of "State-wide" or "local importance." Plans are to complete, within three years, maps for 1000 counties in which substantial shifts to non-agricultural uses are in process or are important.

Another activity of LIM is a survey now underway employing a subsample of the CNI sample plots. The objectives of the survey are to develop estimates statistically sound at the State level: (1) updating tabulations of land use by land capability class from 1967 to 1975, (2) assessing the potential for development as cropland of land not now so used, and (3) for land with good potential, determining the level of development needed to bring it into cultivation. Hopefully, the results will be available for use by mid-1976.

USGS Land Use Data and Analysis Program (LUDA) An important emerging source of comprehensive land use data is the inventory effort begun in the U.S. Geological Survey several years ago. The initial nationwide collection of land use and land cover data is scheduled for completion within 5 years. Individual use-cover maps and associated data are released as completed. When in full operation, change will be monitored on a 5-year basis.

The primary output of LUDA is a series of maps showing present land use and cover at Level II of the USGS classification system. 13/ For each map, overlays will be made showing Federal land ownership and boundaries of river basins and subbasins, counties, and census subdivisions of counties, plus State land ownership when that information is made available to USGS by the State.

The minimum mapping unit for urban and builtup uses, water areas, confined feeding operations, other agricultural land, and surface mining will be 10 acres. All other categories will be delineated in minimum units of 40 acres. Federal and state holdings will be shown for tracts of 40 acres or larger.

Statistical data are to be compiled for counties, areas of Federal ownership, river basins and subbasins, and by subcounty Census tracts or subdivisions.

Basic work will be completed for almost one-third of the country by the end of Fiscal Year 1976.

ERS Proposed Resource Economic Survey. Most of the data outlined within previous sections are on the physical aspects of the land surface. Data on the economic aspects of land, water, and environmental resources are limited. ERS recognizes this deficiency and has proposed, by means of an annual resource economic survey, to expand the data base relating to economic aspects of land and water resources. Objectives of this effort would be to improve the quantity and quality of resource economic

13/ Anderson, et al. Op. cit.

data, improve the timeliness of providing economic information to support programs and policies, and broaden the range of analyses of problems relating to national resource allocation, use, and development.

It takes time to develop an economic analytical system. Even more time is required to generate financial support for the collection of data needed for economic analysis of resource use planning problems. This data system needs to complement data available from the sources listed in the previous section and to be compatible with procedures used in the collection of physical data.

An annual survey would consist of two parts: (1) a national survey to obtain social and economic data on a 5-year rotating basis in five major subject matter areas, including resource ownership, factors associated with land use changes, land improvements, water use, and environmental and conservation measures; and (2) rotating surveys in each of the five major multistate regions to obtain data on (a) problems of regional concern, and (b) a core set of data that would be combined for a national summary at the end of the 5-year cycle.

The following is a partial list of economic data proposed for five major data areas:

1. Ownership of Resources in Rural America

   - Resource ownership in rural areas, with particular attention to type of owner, concentration of landownership, length of ownership, and tenure status and residence of farm operator.

   - Land values, including market prices, economic value, benefits of various areas to society, and relationship of land to use.

   - Resource uses, previous changes in these uses, and factors affecting use.

   - Rules affecting land transfers, cost of resource transfers, and efficiency of recording, title research, and other transactions costs.

   - Shifts in ownership as a result of subdivision, development, fragmentation by public programs such as highway construction, extensive interstate recreational promotion, and other nonfarm uses of land.

   - Taxes, land use controls, and other institutions that affect decisions on land use and transfer.

- Plans, motives, and other characteristics that influence landowners' responses to market prices, government policies, and natural resource programs concerned with the future use of land and other resources.

2. Factors Associated with Land Use Changes

- Land prices, property taxes, urbanization, and other site-specific factors associated with land use changes.
- Identification of regional shifts in patterns of land use and information on factors associated with shifts.
- Extent of land factors associated with economic abandonment of agricultural land.
- Recreation demand for land.
- Owner attitudes and intentions regarding future land use.
- Public and private competing uses for rural land.
- Energy development impacts on land use.

3. Costs and Returns of Land Improvements

- Economic factors affecting land improvement decisions.
- Cropland development potential of noncropped parcels.
- Economic potential for application of irrigation water.
- Economic availability of irrigation water.
- Capital investment requirements in drainage.
- Cost of land clearing.
- Range improvement costs and investment.
- Land productivity.
- Federal and other subsidies received for land improvement.
- Economic impacts of land improvement activities.

4. Water Use and Water Quality

- Economic factors affecting water use decisions.
- Rural and agricultural water supply and use.
- Cost of land preparation for irrigation.
- Cost of ground and surface water development for agricultural and municipal uses.
- Benefits and costs of water conservation practices in agricultural, food processing, and municipal uses.
- Sources of financial for water development and use.
- Capital investments in irrigation, by type of system.
- Capital investments in impoundments.
- Water use efficiency, economic implications and management requirements.
- Productivity of irrigated cropland.
- Economic impacts of changes in water use.
- Economic impact of environmental constraints on water quality.

5. Conservation and Environmental Practices

- Economic factors affecting adoption of conservation and pollution abatement practices.
- Sources of pollution in rural areas.
- Levels of pollutants from agricultural production.
- Capital requirements and costs for conservation practices on cropland and range.
- Investment requirements and cost of point source control of agricultural pollutants.
- Extent of land application of animal wastes, municipal sludge, and effluents.
- Benefits and costs of land application of animal waste and sludge.

Many resource problems require small-area geographic detail if relevant data are to be made available for economic analysis. The need for greater detail places important demands on sampling and other technical requirements and the level of funding needed to obtain adequate data for regional problem analysis. Thus, a series of regional studies and data collection would be undertaken by five major regions of the Nation--the Northeast, Southeast, North Central, Great Plains, and West.

Research Needs

Bonnen has pointed out that economists are responsible for developing the concepts that define and specify data. In accordance with that thought, some profitable research areas would be:

1. Identification of users of land information, kinds of decisions made regarding land, and kinds of data and information needed.

2. Identification of specific functions involved in land use planning, and determination of specialized information needed for each function. For example, provision for open space, development of recreational facilities, routing of highways, siting of electric generating plants, and preserving prime agricultural land.

3. Comparative analysis of information needs at different levels of government and by different types of private groups.

4. Design and testing of decision models for comprehensive land use planning, as well as for more specialized facets of planning.

5. Development and testing of grids and other techniques for handling data in alternative spatial configurations.

6. Development and testing of land use and land capability classification systems.

7. Analysis of alternative organizational structures for operation of inventories and other land use information systems.

8. Adaptation, development, and testing of emerging technology such as remote sensing for obtaining basic data.

9. Evaluation of alternative data processing systems for land use planning.

10. Evaluation of alternative delivery systems for land resource information; i.e., determine the best means of getting information into the hands of decisionmakers.